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EMAARAT

VOLUME 3



SUSTAINABLE CONSTRUCTION

A MAGAZINE BY CIVIL DEPARTMENT

A photograph of the Thakur College of Engineering and Technology building, a large, multi-story structure with a central dome and two prominent towers. The building is set against a cloudy sky. In the foreground, there is a green lawn and a path leading towards the building.

THAKUR COLLEGE OF ENGINEERING AND TECHNOLOGY

Thakur College of Engineering & Technology (TCET) was established in academic year 2001-02 with a clear objective of providing quality technical education in tune with international standards and contemporary global requirements. The College is recognized by All India Council for Technical Education (AICTE) & Govt. of Maharashtra and is affiliated to the University of Mumbai (UOM). All the courses at the U.G. level, eligible for accreditation in 2011 i.e. Electronics & Telecommunication (EXTC), Information Technology, IT and Computer Engineering (CMPN) were accredited by NBA for three years w.e.f. 16.9.2011. Moreover, these programs are also given permanent affiliation w.e.f. A.Y. 2015-16 onwards. The management's commitment to excellence and relevance in technical education is reflected in the marvelous infrastructure that is comparable to the finest institution of its type in the country. The imposing five-storied building, housing state-of-the-art computer laboratories, spacious classrooms, well equipped laboratories, workshops, computer centre with server room, a well-stocked library, wide and well lit clean corridors and a large canteen, conference hall, seminar halls has set new standards in providing facilities of international level.

DEPARTMENTAL VISION

“To become a department of national relevance in the field of Civil Engineering.”

DEPARTMENTAL MISSION

The department of Civil Engineering is committed to provide undergraduate students with sound knowledge in the field of civil engineering, and build in them leadership and managerial skills along with inculcating the culture of lifelong learning and social sensitivity.

DEPARTMENTAL MENTOR



DR . SANJAY KUMAR

PhD (Mechanical Engg.)

M.Tech (Industrial Engg. & Management)

B.E (Production Engg.)

Take up one idea. Make that one idea your life – think of it, dream of it, live on that idea. Let the brain, muscles, nerves, every part of your body, be full of that idea, and just leave every other idea alone. This is the way to success.

The students of Civil department undoubtedly have done their level best in achieving the virtue of standing out differently amongst all departments with their inquisitive ideas and intriguing researches.

It's been an immense pleasure for me to be a mentor for the department and I am proud of their setup of thought process and mind evoking articles.

Within a short span of time there is been a lot of development in their way of presentation and it is highly appreciable.

I heartily congratulate all faculties, students and staff associated with this departmental magazine, E-MARAAT.

HEAD OF DEPARTMENT



DR. SEEMA JAGTAP

Ph.D. Technology
(Civil Engineering)
M.Tech Civil
(Hydraulics Engineering)
B. E.(Civil Engineering)

Building something is not as easier as breaking it. We at TCET feel pleasure that our students get a golden opportunity to bless themselves by knowledge and team work by integrating everything in this magazine, Emaarat.

I feel honor to be a part or this as our students have given their level best and have emerged as a sustainably developed future. Our theme this year, “Sustainable Construction” , describes how concerned our students are towards a well-sustained future of innovative minds. In spite of taking up a technical theme, bringing up different ways to live desirably, we have come a long way. And I would like to thank the mentors and editors for this brainstorming transition.

The activities conducted by ASCE is remarkable. The overall development of our students assures me for a bright and constructive future ahead of these budding minds.

I wish them luck and also bless them for their good work and capabilities to come up with the magazine this year



FACULTY IN CHARGE

MRS. RUTUJA SHINDE

M.E
(Water Resources &
Environmental Engineering)
B.Tech (Civil)

When sustainability flourishes the light of development shines brighter than the sun.

We believe that this year's magazine will do wonder in the era of civil engineering as it focuses on sustainable construction. I feel proud to introduce you with our wonderful magazine, our 3rd edition of Emarat. Our students have driven themselves out of their comfort zone of construction to attain sustainability in the very same domain.

They have given their very best and have shown that what could intellectual and young minds do in this century of advanced technology.

To live up on our legacy since last year from Environmental importance to sustainable construction we have achieved a quantum leap.

I am obliged to encourage my students and to motivate them to always live in their zeal and enthusiasm. I wish them good luck and hope that their hardwork and passion for building this startling magazine flourishes with flying colors.



EDITORIAL'S DESK

PARTH TAMBOLI

EDITOR

Life is not all about opportunities, it's about how we take them and use it to the fullest.

I feel highly obliged and intense pleasure to bring into limelight our 3rd edition of Emaarat.

Our theme this year 'Sustainable Construction', reflects our mindset of bringing on a better and safe future ahead. To grab in this opportunity, I would like to give my utmost gratitude to our mentors and our team, for working hard and dedicatedly in the creation of our magazine.

It's been years and we always strive to come up with something different and that always keeps us in bringing it something out of the league. This year we have brainstorming articles based on research, projects as well as information regarding the development in construction with respect to sustainability. We have brought up information interviews which match with our similar interests.

I wish and hope that you all like our magazine this year too as always, and show your love to the hardwork and passion of civil engineers.



EDITORIAL'S DESK

KEERTHANA NAMBIAR

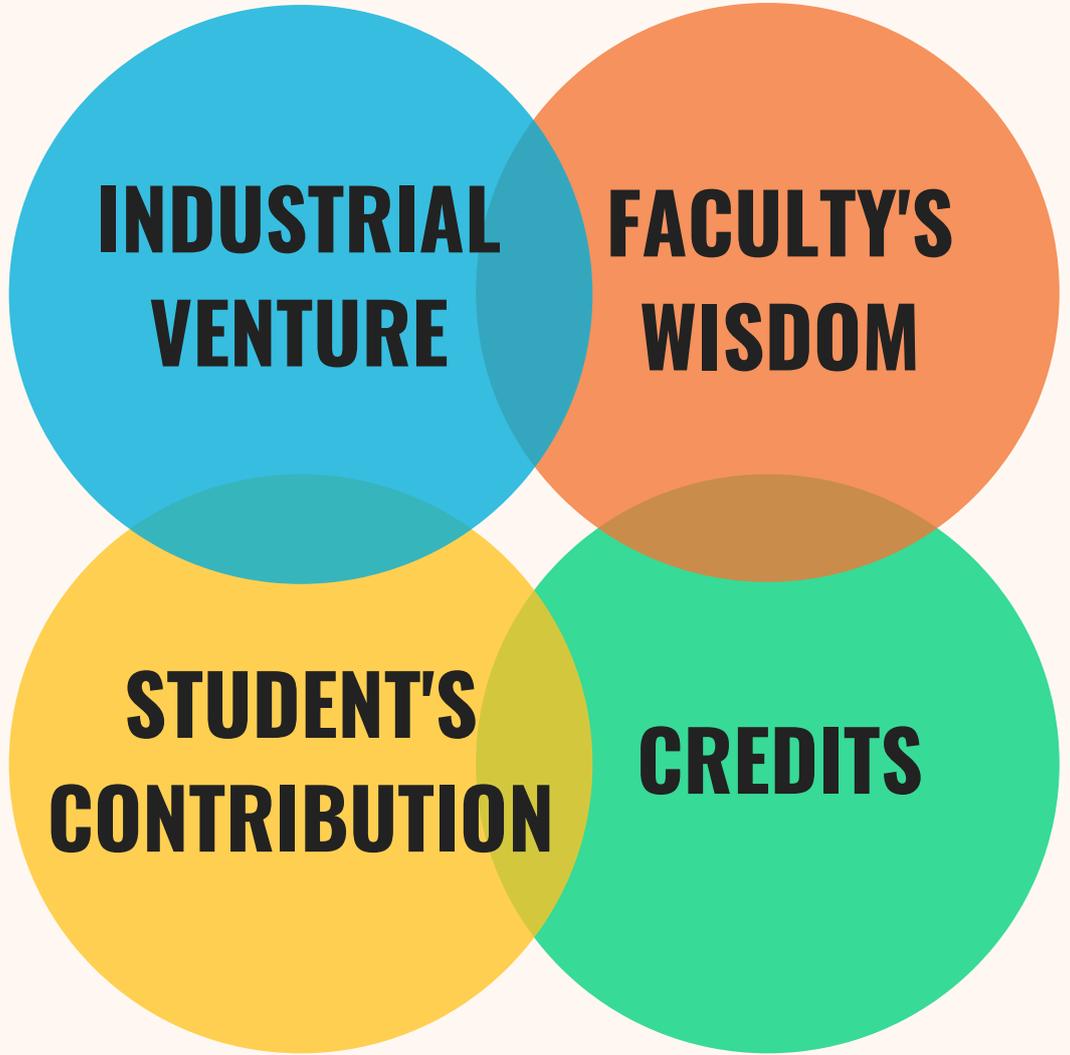
MAGAZINE HEAD

It's our immense pleasure to put forward our third edition of 'Emaarat', Civil department magazine. In the world of technicality and progress in Science, We the students of Civil Engineering at a very primitive stage of exposure have given a diversified information about the "need of the hour" that is, sustainable construction. From learning simple and facile ways of construction to understanding the importance of sustainability in construction, we all have inculcated the insights of exploring ourselves and the minute detailing, giving an exclusive knowledge of, depth of research work. A heartfelt gratitude to our mentors who have guided us throughout the process of generating this masterpiece and exclusive blend of young and intellectual minds that has raised its bars this year by remarkably including a high range of articles relating to variety of concepts and project based research of our students. "We must learn to live together as brothers or we will perish to get her as fools", the consensus and cooperation of our team was prodigious in itself and we are obliged to everyone who have contributed in the making of this startling magazine.

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E-MAARAT



EMAARAT

INDUSTRIAL VENTURE

with Mr. Sunil Shah

Bachelor in Civil Engineering from Birla Vishwakarma
Mahavidyalaya (Sardar Patel University) Vallabh Vidhyanagar
in 1993

Work: As DGM Project at Ajmera Realty and Infra India Limited

1. TELL US ABOUT YOUR JOURNEY FROM BEING A CIVIL ENGINEERING STUDENT TO A SUCCESSFUL CIVIL ENGINEER.

In those days there was no concept of internship during study itself. We could get the first hand experience only after completion of graduation. Also being coming from rural background, I could not see any big construction going on nearby. Now I always keep in touch with new invention and technology and adopt it. Even today gets me updated for any change in industry. I started from execution of small building to 40 storied buildings. I worked from small village and remote places to metro city. I changed from execution at site to planning and liaisoning. So always be ready for change.

2. WHAT EFFORTS DO YOU RECOMMEND A STUDENT TO PUT DURING HIS/HER STUDY YEARS, WHICH WOULD BE HELPFUL TO MAKE HIM/HER INDUSTRY READY?

Keep visiting nearby construction work going on, attend seminars presented by industry people, and study various reference books in the subject of interest. Always try to correlate your study with the practice.

3. IN THE CURRENT AGE OF GROWING OPPORTUNITIES IN ENTREPRENEURSHIPS, WHAT IS THE SCOPE OF CIVIL ENGINEERING STUDENTS IN THIS FIELD?

I feel there always be opportunity for Civil Engineers as it is related to the basic need of people, Home. Also to grow any industry or area, development of infrastructure is essential. Civil work is the first requirement of establishing any new industrial plant.

There are many different streams on opportunity. The Civil engineering is divided mainly in to two sectors. Infrastructure and housing.

In each sectors there are various streams like Designing, planning, estimating, tendering, execution, liaisoning, material procurement, interior finish work etc.

Most of the persons working in the field work as Manages instead of Civil Engineer. They need only basic knowledge as civil engineer. Only Structural designer and consultants need technical knowledge.

4. WHAT ARE YOUR PREDICTIONS ABOUT THE INNOVATIONS AND DEVELOPMENT IN THE FIELD OF CIVIL ENGINEERING?

It is expected that more and more automation is coming up. Now days there are machines available for even plastering, scaffolding is replaced by hanging mechanised platform, modular formwork is now considered old one, design software's are becoming more advanced, Precast elements are now available to reduce work at site, Revit and Achicad are replacing Autocad but to run all this automation you always need to have basic knowledge of civil engineering.

5. WHAT IS YOUR ADVICE FOR ASPIRING CIVIL ENGINEERS?

Keep your eye, ear and mind open. Analyse every activity going on around you commercially and technically. Do not go by the notions that if it is in practice since long does not mean it cannot be done in more correct and better way. Always be quality conscious.

6. DO YOU BELIEVE IN THIS AGE OF INDUSTRIALIZATION IT IS POSSIBLE TO STRIKE A BALANCE BETWEEN ENVIRONMENT AND BUILDINGS?

Yes, there are always better way to do any development more environmental friendly. Development can be done environment friendly at all stage from Conceptualisation, design, construction and operational phase. Development cannot be stopped but can be done in most optimum way so as to balance between development and environment.

7. WHAT ARE THE IMPORTANT QUALITIES IN A STUDENT THAT ARE SEARCHED FOR, WHILE RECRUITING FRESHERS?

From fresher interviewer always look to the attitude of a candidate, Reactions to odd questions, approach to arrive at an answer and basic technical knowledge for working at site.

8. WHAT ACCORDING TO YOU ARE THE MOST IMPORTANT INVENTIONS IN THE FIELD OF CIVIL ENGINEERING TILL NOW?

Invention of Reinforced Cement Concrete is most important as it has changed the way design of buildings and made it possible to construct high-rises.

EMAARAT

INDUSTRIAL VENTURE

with Mr. Rohan Bansode

Bachelor In Civil Engineering (Structures)

Work :4 years of work experience

Runs his own firm

1. TELL US ABOUT YOUR JOURNEY FROM BEING A CIVIL ENGINEER STUDENT TO A SUCCESSFUL CIVIL ENGINEERING

My journey was as a driving force for me as it was all full of ups and downs. When we talk about industries or working in a firm the reality is totally different from what we used to think back then in college. Here we need more practical knowledge, whereas theoretical is always a necessity.

2. WHAT EFFORT DO YOU RECOMMEND A STUDENT TO PUT DURING HIS/HER STUDY YEARS, WHICH WOULD BE HELPFUL TO MAKE HIS/HER INDUSTRY READY?

When we talk about experience a student cannot fulfill the criteria until he/she doesn't step down the field. Hence field knowledge always turns out to be useful, because it's like an icing on the cake of your resume.

Try to focus on subjects, not just for the matter of fact that we are bound to study it rather than that love them and try to expand your boundaries.

3. HOW IMPORTANT, ACCORDING TO YOU, IS JOB EXPERIENCE IN THE FIELD OF CIVIL ENGINEERING?

As already mentioned, field experience is a plus point for any newbie in the industry. So try and focus on opting internships in your 4-year course. It will be really helpful to understand your strengths and weakness as well.

4. IN THE CURRENT AGE OF GROWING OPPORTUNITIES IN ENTREPRENEURSHIP, WHAT IS THE SCOPE OF CIVIL ENGINEERING STUDENTS IN THIS FIELD?

Technology undoubtedly is growing tremendously and civil engineers need to maintain their pace along with it. Entrepreneurship is a virtue of different personalities. Well not spilling the beans much, but yes civil engineers could be the best entrepreneurs as they have all apt skills required for it due to their field work and knowledge.

5. WHAT QUALIFICATIONS ARE CONSIDERED IN A CIVIL ENGINEERING STUDENT APART FROM HIS/HER BE DEGREE?

AutoCAD and STAAD are the software which everybody recommends. But I would also like to ask students to try Ms-Excel/Advanced Excel, as it will be ultimately important in the near future.

6. WHAT ARE YOUR PREDICTIONS ABOUT THE INNOVATIONS AND DEVELOPMENT IN THE FIELD OF CIVIL ENGINEERING?

I believe what is building us to grow more smarter and smarter day by day is technology. Focusing more on that IOT is the next doorstep for innovation and development in civil engineering sector too.

7. WHAT ARE THE ASPECTS OF CIVIL ENGINEER THAT ARE TRENDING AT PRESENT?

As we know that construction are helping in rapid growth of economy of their country. Building tall towers, sea links, underground sea tunnel & bridges.

8. THROUGHOUT YOUR JOURNEY IN CIVIL ENGINEERING, WHAT INVENTIONS & INNOVATION HAVE U WITNESSED THAT MAY BE CONSIDERED REMARKABLY IMPORTANT TO THIS FIELD?

Well there are many structures to note here, but one of my favorite is the Kohinoor Square, Dadar.

9. CAN U SUGGEST SOME NEW PROJECTS FOR THE STUDENT?

Sustainable construction and structures which could handle all sorts of natural calamities.

10. WHAT IS YOUR ADVICE FOR ASPIRING CIVIL ENGINEERS?

Civil engineering field is a field which doesn't requires much adversity but still innovative ideas and techniques must be appreciated. The young budding minds should come up with various links with civil sector which could be beneficial to the country and humanity as whole.

EMAARAT

INDUSTRIAL VENTURE

with Mr. Abhinav Kashyap

Master In Civil Engineering (Structures) 2005

University of Sheffield (U.K.)

IPMA Level - D, PMA certified

Bachelor in civil engineering from Nagpur university 2003

**Work : National Petroleum Construction Company (NPCC),
Abu Dhabi, UAE**

Post: Project Engineer coordinator

1. TELL US ABOUT YOUR JOURNEY FROM BEING A CIVIL ENGINEER STUDENT TO A SUCCESSFUL CIVIL ENGINEERING?

My journey has been quite enjoyable, I passed out my masters in year 2005 from University of Sheffield UK, I worked at Larsen & Toubro EPC Company as A Project engineer in oil & gas structure. Applied in various Company. Then I Moved to Abu Dhabi & started working in NPCC as a Project engineer coordinator.

2. WHAT EFFORT DO U RECOMMEND A STUDENT TO PUT DURING HIS/HER STUDY YEARS, WHICH WOULD BE HELPFUL TO MAKE HIS/HER INDUSTRY READY?

Civil engineering is divided into 2 parts i.e. design & structures, you should do internships in design & start your job with structures that will give you core knowledge about on field work of civil engineering. You should focus on your electives in 7th semester which will train u for your main goal.

3. HOW IMPORTANT, ACCORDING TO YOU IS JOB EXPERIENCE IN THE FIELD OF CIVIL ENGINEERING?

Job Experience is highly important in civil engineering. We want engineers with some experience of field work. You all should do internship in design & work in structures around 3 years.

You should have talent to implement your study on field
Plan -> FEED -> Retail design-> construction

4. IN THE CURRENT AGE OF GROWING OPPORTUNITIES IN ENTREPRENEURSHIP, WHAT IS THE SCOPE OF CIVIL ENGINEERING STUDENTS IN THIS FIELD?

It is difficult to become a entrepreneur in field of civil engineering but it is not impossible. You should have attest 5 years of experience, should have good knowledge of design codes specially UK & EURO design codes.

5. WHAT QUALIFICATIONS ARE CONSIDERED IN A CIVIL ENGINEERING STUDENT APART FROM HIS/HER BE DEGREE?

A Civil engineer should have knowledge about 2 main software i.e. AutoCAD & STAAD. Participate in civil conferences

6. WHAT ARE YOUR PREDICTIONS ABOUT THE INNOVATIONS AND DEVELOPMENT IN THE FIELD OF CIVIL ENGINEERING?

- Under river bed tunnel in India.
- Construction of tallest tower in Saudi Arabia
- Nanotechnology in civil engineering

7. WHAT ARE THE ASPECTS OF CIVIL ENGINEER THAT ARE TRENDING AT PRESENT?

We know that construction are helping in rapid growth of economy of their country. Building tall towers, sea links, underground sea tunnel & bridges.

8. THROUGHOUT YOUR JOURNEY IN CIVIL ENGINEERING, WHAT IS INTENTLY IMPORTANT TO THIS FIELD?

Millenium bridge in UK used tuned dampers to avoid swing
Form work
Biggest water cran used in construction of Palm island.

9. CAN U SUGGEST SOME NEW PROJECTS FOR THE STUDENT?

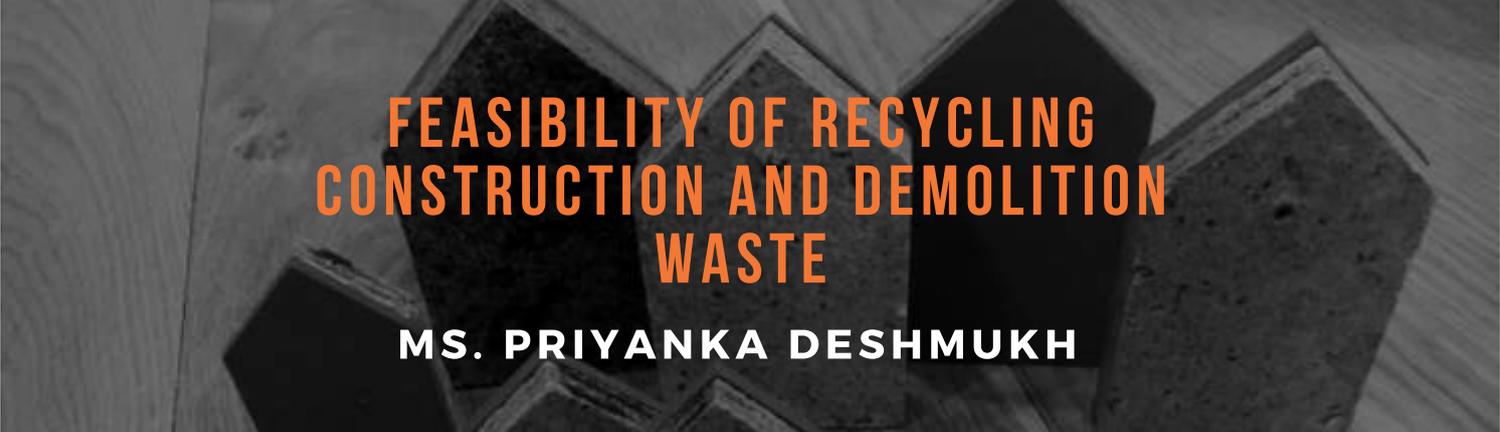
Use FRP Polymer for construction of bridge

10: WHAT IS YOUR ADVICE FOR ASPIRING CIVIL ENGINEERS?

They should know how to use their knowledge on the field work & have to study hard while participating in different extracurricular activity. Learn something apart from Indian civil industries. Try attending civil conference.

EMAARAT

FACULTY'S WISDOM



FEASIBILITY OF RECYCLING CONSTRUCTION AND DEMOLITION WASTE

MS. PRIYANKA DESHMUKH

1. Introduction

India has emerged as one of the world's second fastest growing economies. As a result of this rapid economic growth, a significant increase has been observed in the construction activities over the recent years. According to a research carried out by Centre for Science and Environment (CSE) in 2014, the construction activities in India are growing at an annual rate of 10 per cent over the last decade as against the world average of 5.5 per cent per annum. According to eleventh year plan, construction industry in India is the second largest economic activity after agriculture. It accounts for nearly 65% of the total investment in infrastructure. Investment in construction accounts for nearly 11% of India's Gross Domestic Product (GDP). A total amount of Rs. 2,05,42,050 million is projected to be invested in infrastructure according to 11th five year plan. During the Tenth Plan, about 25 per cent of the total investment in infrastructure came from the private sector. This is expected to rise to about 36 per cent during the Eleventh Plan. While there may be a shortfall of about 8.7 per cent (Rs.12,52,660 million) in public investment as compared to the initial targets for the Eleventh Plan, this is likely to be made good by an increase of about 20 per cent (Rs.12,33,210 million) in private investment. The investment in infrastructure is likely to rise from 5.15 per cent of GDP during the Tenth Plan to about 7.55 per cent during the Eleventh Plan, as against a target of 7.60 per cent. This constitutes a significant shift in favour of investment in

infrastructure. A preliminary assessment suggests that investment in infrastructure during the Twelfth Plan (2012-17) would need to be of the order of about Rs.40,99,240 million (US \$ 1025 billion) to achieve a share of 9.95 per cent as a proportion of GDP.

1.1 Construction and Demolition Waste: (C & D Waste)

Construction and demolition waste is generated whenever any construction/demolition activity takes place, such as, building roads, bridges, fly over, subway, remodelling etc. It consists mostly of inert and non-biodegradable material. In addition, it includes the materials generated as a result of natural disasters. Central Pollution Control Board has estimated current quantum of solid waste generation in India to the tune of 48 million tons per annum of which waste from Construction Industry accounts for 25%. The total quantum of waste from construction industry is estimated to be 12 to 14.7 million tons per annum.

Considering the thumb rule stated by Technology Information, Forecasting and Assessment Council (TIFAC), a new construction generates 40-60 kg of C&D waste per sq m. if an average of 50 kg per sq m is assumed, the C&D waste generated between 2005 and 2013 is approximately 287 MT, 1 billion sq m in 2013 itself. This estimate only accounts for new construction. Demolition of existing structures generates 10 times more C&D waste than that during construction (i.e. 300-500 kg of waste per sq m). Building repairs generate 40-50 kg

FACULTY'S WISDOM

per sq m of waste. Thus, the total estimate of C&D waste generated in 2013 itself was 530 MT, 44 times higher than the official estimate.

1.2 Management of C&D Waste:

Due to its inert nature, C&D waste cannot be subjected to composting or incineration as a method of treatment. Moreover, the wastes are being disposed off improperly and illegally in order to avoid transportation and tipping costs. Farm land, prime residential areas, pits and low lying areas have become disposal sites. These landfills have also become threats to ground water contamination. Moreover, the boom in the construction industry has increased the stress on natural resources.

According to a study commissioned by Technology Information, Forecasting and Assessment Council (TIFAC), 70% of the construction industry is not aware of recycling techniques.

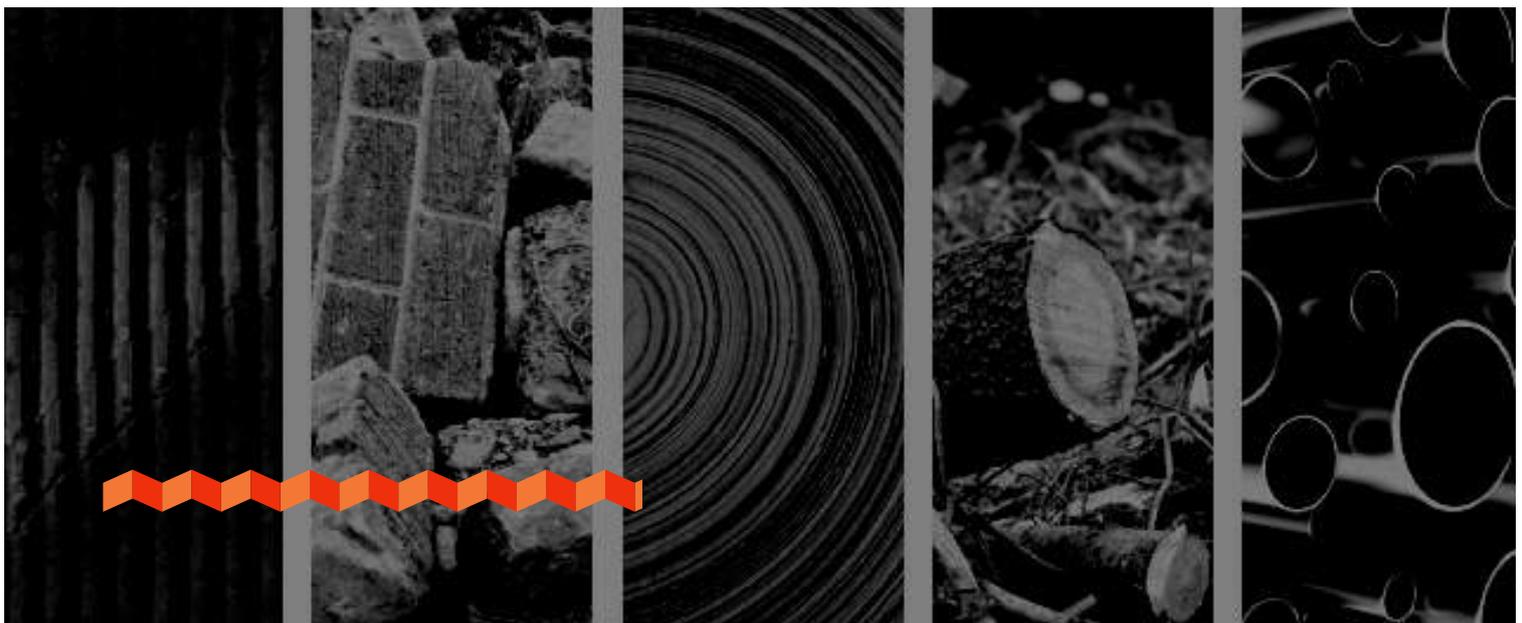
Benefits of Recycling:

Following are the benefits of recycling:

- It reduces the emission of greenhouse gases.
- It reduces the need to extract raw materials and transporting the materials long distances. It reduces the need for new landfills and the costs involved in it.
- Recycling saves energy and also reduces the environmental impact.
- It creates employment opportunities in recycling industries. Advantages are reduced disposal of waste to landfill sites and reduced mineral extraction.

1.3 Examples of Recycling in India:

Even though legal reform in this area is taking a long time in India, several architects have already taken steps to reuse waste in their buildings. There is the example of a school building in Rajkot designed by Ahmedabad based architect Surya Kakani that has been built from the debris of Bhuj earthquake. The Institute of Rural Research and Development (IRRAD) building in Gurgaon has innovatively recycled and utilised its own construction waste in the building itself. But these are limited steps and they will have to be encouraged with policy and fiscal support.





Sustainability means use of naturally available things which is very useful in our present life. This is also mean the reuse of different waste material. Sustainability is the way by which we have sustain our life by natural things. In this fasten this concept is very useful for living a good life. By adopting this concept we can enjoy the natural things which minimum cost and due to this sustainability concept we maintain the environmental conditions stable. Following are the different and some important sustainable effects as follows.

- 1) Green building
- 2) Rainwater harvesting
- 3) Solar system

1) Green building:

In the present world pollution get increases due to the increase in vehicle , Industries etc which results in the carbon dioxide gases. If use the concept of green building for our building we can get lot of advantages in this system we laid the plants on our building walls and slabs and the plants the tree around your building. Buy this planting plants absorb the carbon dioxide gas and keep our building pollution free and also due to the green building our houses is always cool without applying any energy like fan and ac so we can optimize the energy resources And we can save the other overhead charges and the electricity.

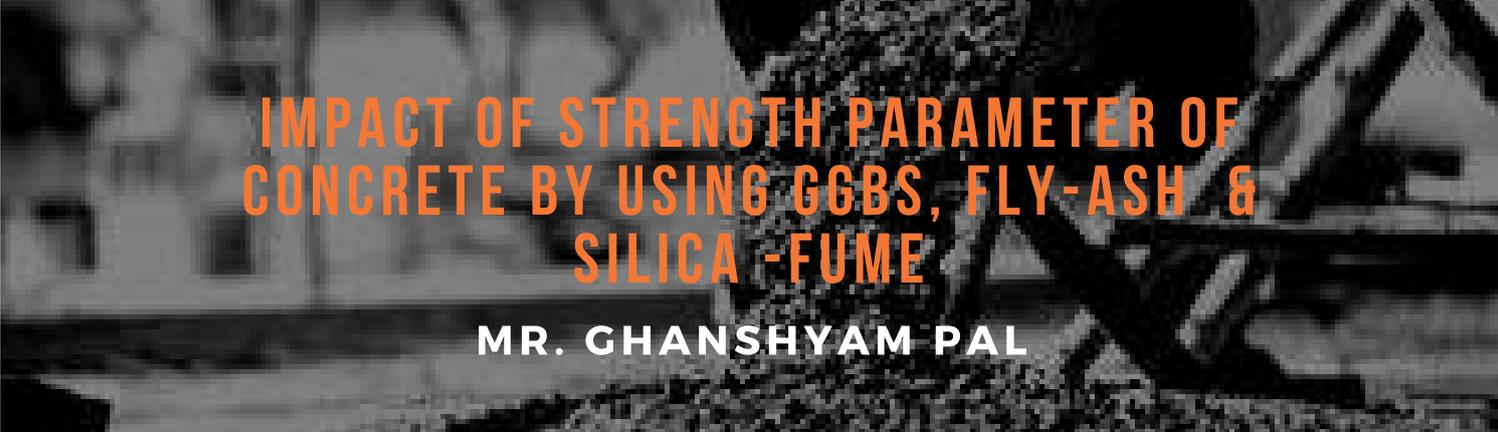
2) Rainwater harvesting-

Whenever we look there maybe shortage of water in every place. To minimize the salt is there may be very simple method of increase

the water level. Buy this concept of rainwater harvesting we can save the water in rainy season. in rainy season we can store this rain water in the bore by increasing the water level or store this rain water by constructing the Ponds are tanks. This store water we can use for bathing or other purposes throughout the year and you can save the water by this concept.

3) Solar system:

By the system we can make the water hot with minimum cost. In the system only solar system assembly is used. In the solar system we can make the hot water by minimizing the electricity caused due to this solar system concept is economical. This above are the some simple examples by adopting which we can save the water electricity and maintain our building pollution free. adopt the sustainability concept in our life this is the need of present world by which we can make our life simple economical and reliable.



IMPACT OF STRENGTH PARAMETER OF CONCRETE BY USING GGBS, FLY-ASH & SILICA - FUME

MR. GHANSHYAM PAL

The Ordinary Portland Cement (OPC) is one of the main ingredients used for the production of concrete. Unfortunately, production of cement involves emission of large amounts of carbon-dioxide gas into the atmosphere, a major contributor for green house effect and the global warming, also construction industry, use of concrete is going on increasing rapidly. Cement is major constituent material of the concrete, which produced by natural raw material like lime and silica. Once situation may occurs there will be no lime on earth for production of cement. This situation leads to think all people working in construction industry to do research work on cement replacing material and use of it. hence it is inevitable either to search for another material or partially replace it by some other material. The search for any such material, which can be used as an alternative or as a supplementary for cement so we had taken a research for partial replacement of cement by combinably mixing **GGBS, FLY-ASH & SILIKA FUME** in a varying percentage and checking effect of special material on concrete.

Concrete has basic naturally, cheaply and easily available ingredients as cement, sand, aggregate and water. After the water, cement is second most used material in the world. But this rapid production of cement creates two big environmental problems for which we have to find out civil engineering solutions. First environmental problem is emission of CO₂ in the production process of the cement. We know that CO₂ emission is very harmful which

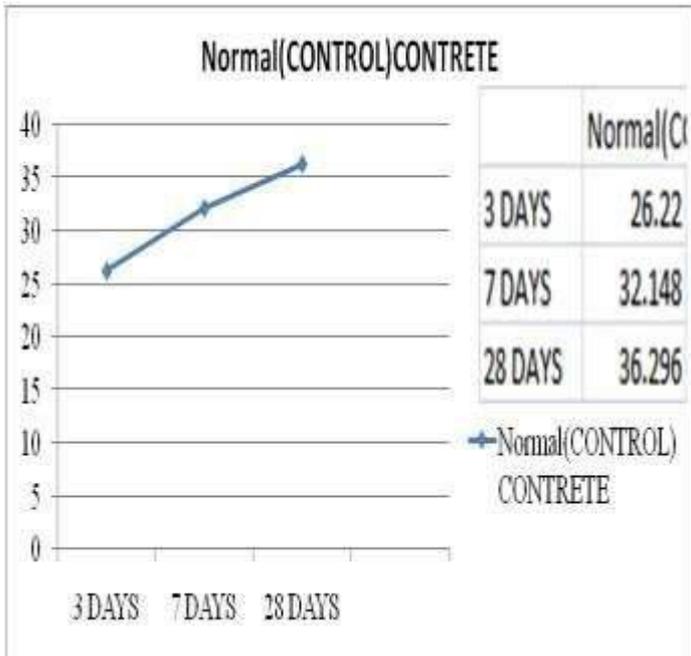
creates lots of environmental changes whatsoever. Ground Granulated Blast furnace slag (GGBS) is a by-product for manufacture of pig iron and obtained through rapid cooling by water or quenching molten slag. Here the molten slag is produced which is instantaneously tapped and quenched by water. This rapid quenching of molten slag facilitates formation of "Granulated slag". Ground Granulated Blast furnace Slag (GGBS) is processed from Granulated slag. Fly ash is one of the residues created during the combustion of coal in coal-fired power plants. Fine particles rise with flue gasses and are collected with filter bags or electrostatic precipitators. Silica Fume is a finely-divided mineral admixture, available in both uncompact and compacted forms. This ultra-fine material will better fill voids between cement particles and result in a very dense concrete with higher compressive strengths and extremely low permeability.

RESULT

Compressive strength test on cube: cube compression test was performed on standard cubes of plain size 150mm x 150 mm x 150mm at 28 days of immersion in water for curing.

CONTROL CONCRETE (Normal Concrete Without Replacement) OF M30 (1:1.47:1.9) GRADE.
DAYS / 3DAS 7 DAYS 28 DAYS
STRENGTH(Mpa)

DAYS / STRENGTH (Mpa)	3DAYS	7 DAYS	28 DAYS
NORMAL CONCRETE (CONTROL CONCRETE (1:1.47:1.9))	26.22 Mpa	32.148Mpa	36.296Mpa



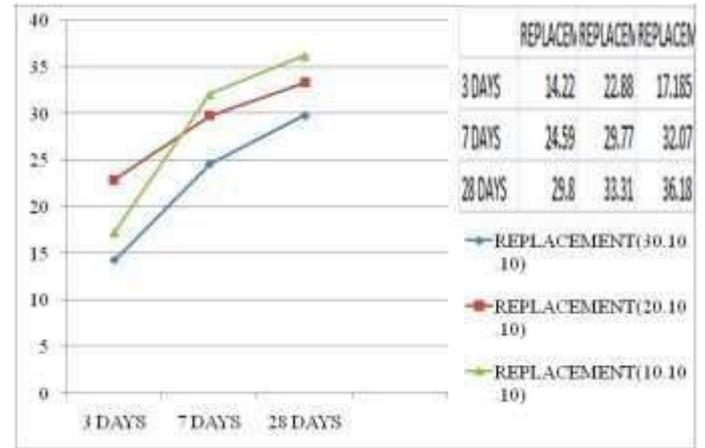
X-AXIS =DAYS, Y AXIS= STRENGTH OF CONCRETE DAYS (N / mm²)

REPLACING 50 % OF CEMENT BY GGBS,FLY-ASH & SILIKA FUME .

GGBS: FLY-ASH: SILIKA-FUME) (Table Below.)

DAYS / STRENGTH (Mpa)	3 DAYS	7 DAYS	28 DAYS
Cement replacement (30:10:10)	14.22Mpa	24.59Mpa	29.8Mpa
Cement replacement (20:10:10)	22.88Mpa	29.77Mpa	33.31Mpa
Cement replacement (10:10:10)	17.185Mpa	32.07Mpa	36.18Mpa

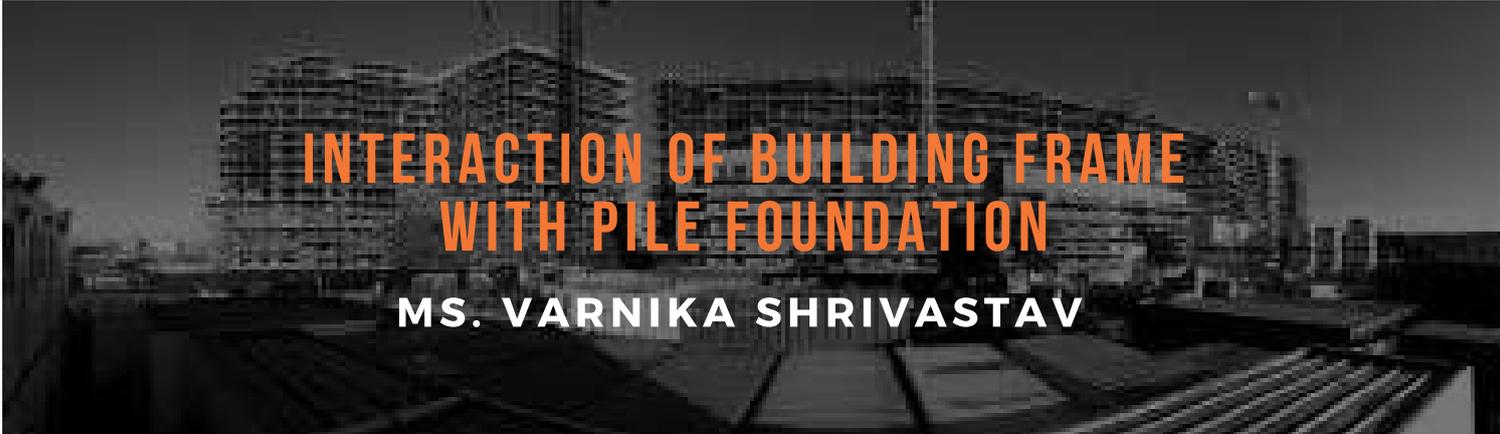
GRAPH SHOWS THE COMBINED EFFECT ON THE STRENGTH (GGBS, FLY-ASH, SILIKA-FUME)



X-AXIS =DAYS ,Y AXIS= STRENGTH OF DAYS (N / MM²)

CONCLUSION

Partial replacement of cement in presence of silika fume and fly-ash, as quantity of GGBS decreases strength of concrete will increases.



INTERACTION OF BUILDING FRAME WITH PILE FOUNDATION

MS. VARNIKA SHRIVASTAV

Introduction

The framed structures are normally analyzed with their bases considered to be either completely rigid or hinged. However, the foundation resting on deformable soils also undergoes deformation depending on the relative rigidities of the foundation, superstructure and soil. Interactive analysis is, therefore, necessary for the accurate assessment of the response of the superstructure. Numerous interactive analyses have been reported in many studies in the 1960's and 1970's and few in recent studies. While most of the above mentioned studies dealt with the quantification of the effect of interaction of frames with isolated footings or combined footings or raft foundation in the context of supporting sub-soil either analytically or experimentally; only the study by Buragohain et al. was found to deal with the interaction analysis of frames on piles until recent past.

The work presented by Buragohain et al. was carried out using the stiffness matrix method and moreover, it was based on the simplified assumptions and relatively less realistic approach. Pointing out the lacunae in the interaction analysis of a framed structure resting on pile foundation reported the methodology for the interaction analysis of a single storeyed building frame embedded in clayey soil on the rational approach and realistic assumptions. Although most of the analyses used sub-structure method (uncoupled approach), few of them used coupled

approach where the structure and foundation were considered to be a single compatible unit. However, the investigations underscored that the sub-structure approach is preferred in such interaction analysis owing to simplicity in the method, less memory requirement on part of the computational resources and not much variation in the results obtained using sub-structure method and coupled approach.

Recently along similar lines, Reddy and Rao reported an experimental work on a model building frame supported by a pile group and compared the results analytically using finite element analysis. Even numerous studies have been reported most recently. However, these studies were confined to the interaction analysis of frames or allied structure supported by isolated footings or raft foundation.

In the meantime, much work is available in the literature on axially loaded as well as laterally loaded single pile and pile groups. The approaches available for the analysis of axially loaded pile foundations include the elastic continuum method and load transfer method, while those for analyzing the laterally loaded pile foundations include the elastic continuum approach and modulus of subgrade reaction approach. With the advent of computers in the early seventies, more versatile finite element method has become popular for analyzing the problem of pile foundations in the context of linear and non-linear analysis.

On the backdrop of the considerable work of the interaction analyses of space frame- pile foundation-soil system reported in the recent past, the interaction analysis of a single storied frame resting on pile foundation is reported in this investigation. However, more refined 3-D F.E. mesh is used for pile foundation, wherein soil elements are discretized using three different elements—eight node, nine node and twelve node continuum elements, as compared to the mesh employed in the similar study wherein the soil mass was discretized using twenty node continuum elements. Further, the effect of spacing between the piles, pile diameter along with the arrangement of piles (such as series and parallel) with respect to lateral loads acting on the frame was considered.

Further, the piles that were modeled were square for simplicity in modeling. However, while considering its effect, they were treated as the circular piles of the diameter equivalent to the size of the square piles. The flexible pile cap along with its stiffness is considered and the stiffness matrix for the sub-structure is derived by considering the effect of all the piles in a group. The behavior of elements of the superstructure and sub-structure including soil is considered to be linearly elastic. The total stress analysis is carried out and immediate behavior of the soil is considered.

Hypothesis in Mathematical Modeling

The interaction analysis is carried out using the finite element method. A typical frame is analyzed separately considering the fixed column bases. Later, the pile foundations are worked out independently to get the equivalent stiffness of the foundation head. Further, they are used in the interaction analysis to evaluate the effect of SSI on the response of the frame.

A three dimensional geometric model of the superstructure frame-pile foundation-soil system. The elements of the superstructure (beam, column and slab) and that of pile foundation (pile and pile cap) are discretized into 20 node iso-parametric continuum elements. On the other hand, soil elements are discretized using eight node, nine node and twelve node continuum elements. Further, three degrees of freedom at each node, i.e.,

displacement in three directions in X, Y and Z of these different elements are employed in the present investigation. To ensure proper mechanics of stress transfer between soil and pile under lateral load, 16 node iso-parametric surface elements is introduced at the interface. The normal and tangential stiffness of these elements are assumed in such a way that shearing at the soil and pile interface is allowed but gapping will be restricted.

Since a 3-D geometric model is used to represent the soil-pile system, selection of the correct finite element to represent the medium is one of the very important aspects in finite element analysis. In the soil- pile system, two materials, viz. soil and reinforced concrete are to be modeled. The either material show different behaviors when subjected to loading. The failure of the soil is dominated by its shear characteristics, whereas the flexure dominated failure is shown by the reinforced concrete. Therefore, pile and pile cap along with the superstructure elements are modeled using twenty node continuum elements. This element has quadratic shape function which is well suited to model the medium with bending dominated deformation. Eight node continuum elements are used to model the soil which has linear shape functions. These elements are suitable for the medium whose deformations are dominated by shear strength. To maintain the continuity of displacements between these two types of elements in the discretized soil-pile domain, two more elements were formulated, viz. twelve node and nine node solid elements.

The shape functions of these two elements were formulated by using degrading technique as employed by Krishnamurthy. The shape functions are derived for these elements by degrading the twenty node solid elements. Twelve node elements are used at the junction where eight node and twenty node element meets. Further, nine node elements are used where twelve node element and twenty node element meets perpendicularly.

Problem Description

A 3-D single storeyed building frame resting on pile foundation, as shown in the 1, is considered for the study. The frame, 3 m high is 10 m × 10 m in plan with each bay being, 5 m × 5 m. The slab, 200 mm thick, is provided at top as well as at the floor level. Slab at top is supported over 300 mm wide and 400 mm deep beam. The beams are resting on columns of size 300 mm × 300 mm.

Two pile groups comprising two and three piles are considered in the present study. Further, two arrangements of piles with respect to the direction of load (series and parallel) are considered. All the piles in a group are circular piles, connected by 500 mm thick flexible pile cap. While dead load is considered according to unit weight of the materials of which the structural components of frame are made up for the purpose of the parametric study presented here, lateral load are also considered. The properties of the material for pile and pile cap.

The mathematical model of the building frame with the modeling idealizations mentioned in the preceding section. For group configuration in series and parallel arrangements, full 3-D

geometric model is used. One subroutine is developed in the program to generate the geometrical and material properties required for finite element analysis. The discretized soil-pile domain for the full 3-D geometrical model which is used for the analysis of four configurations of pile group viz. 2PP (two piles in parallel), 2PS (two piles in series), 3PP (three piles in parallel), 3PS (three piles in series). For analyzing the pile foundation separately a software program Pile routine was used. The analysis of the pile foundation is carried out for the lateral or vertical force (FH or FV) of magnitude of 1000 kN applied on pile cap. The equivalent stiffness, k_h and k_v , are calculated and are further used in the interaction analysis of the frames structure. For the interaction analysis, a software program Build_Frame is developed. The software programs are developed using FORTRAN 90.

After assessing the accuracy of the program in the context of simple problems of structural engineering and soil-structural engineering and further, implementing it on the published work, the said program is used in the present study. In the parametric study conducted for the specific frame the response of the superstructure considered for the comparison include the horizontal displacement of the frame at top of the frame, for both fixed base and soil-structure interaction (SSI) cases.





STUDY OF DELAY IN EXECUTION OF INFRASTRUCTURE PROJECTS – HIGHWAY CONSTRUCTION

MS.YOGITA HONRAO

INTRODUCTION

A commonality among state departments of transportation is the inability to complete transportation projects on time and within budget. Time delay, cost overruns are generally due to factors such as design errors, unexpected site conditions, increases in project scope, weather conditions, and other project changes. A cost overrun may be generally expressed as a percent difference between the final cost of the project and the contract award amount. When this value is negative, it is called a cost under run. A time delay is simply the difference between a project's original contract period at the time of bidding and its overall actual contract period at the end of construction. Indian infrastructure investment in general and highway construction in particular have seen manifold increase in the recent times. This has brought about a paradigm shift in the way in which the highway construction industry has been conducting its business with increased pressure on its stakeholders, namely the employers, the contractors and the consultants for high quality and timely project delivery. A primary goal of highway agencies is to serve the public by providing timely construction of highways with the least disruption to the public. A significant annoyance to the public is when important projects are not completed in a timely manner and when the actual progress of the construction work is longer than necessary, thereby prolonging the inconvenience. The problem of delays in

highway construction has been a priority issue for years.

LITERATURE REVIEW

In analyzing time and cost overruns of construction projects in India, Iyer and Jha (2006) concluded that two success factors and one failure factor; commitment of project participants, owner's competence and conflict among project participants contributed significantly in the enhancement of the performance of a project.

Root causes of delays in construction projects were defined as situations and conditions in sufficient detail that violated the fundamental principles to allow corrective action to be taken (Ellis and Randolph 2003). A listing of most common root causes categorized under seven major categories such as business practices, procedures, utilities, site conditions, planning and scheduling, traffic management and design errors has been provided. Although the survey for root cause of delay from both state highway agencies and constructors were listed separately, it was found that most of them were common for both sides.

Arun and Rao (2007) dealt with an innovative Decision Support Tool that could predict the duration overrun, cost overrun and activities associated with any specific delay in highway construction projects. Simulation models for duration and cost overrun of the project was developed based on the nature of delay,

activities associated with the delay and classified as controllable and uncontrollable factors. Based on the opinion of senior project implementers from sixty four consultants and professionals in highway construction sector of India, the main risk factors were categorized in this work.

The actual problems connected with highway projects of large size with illustrations from one of the packages of the Golden Quadrilateral project spanning between Delhi and Kolkata, India was reported (Sharma 2004).

RESERACH METHODOLOGY

The research through literature reviews and discussion with some parties involved in the construction industry identified a total of 53 causes and 11 effects which are mainly affecting in the delay of Highway construction projects. A questionnaire was developed in order to evaluate the frequency of occurrence, severity and importance of the identified causes. Data were gathered through a survey, analysed by using frequency, severity and importance indices, taking in view owners, contractors and consultants. Agreement on the ranking of the importance of the causes of delay between each two groups of parties was also tested. Recommendations for minimizing delay in construction projects were emphasized in view of the results of the study.

Questionnaire Design:

Data were gathered through a questionnaire. The questionnaire is divided into two main parts. Part 1 is related to general information for both the company and respondent. Owners, contractors and consultants were further requested to answer questions pertaining to their experience in the construction industry and their opinions about the percentage average time delay in projects they experienced. Part 2 includes the list of the identified causes of delay in construction project. These causes are classified into nine groups according to the sources of delay: factors related to owner, contractor, consultant, services and utilities, government regulations and external environment.

For each factor or cause two questions were asked: What is the frequency of occurrence for

this cause? & what is the degree of severity of this cause in project delay? Both Frequency of occurrence and severity were categorized as follows: always, often, sometimes and rarely (on 4 to 1 point scale). Similarly, degree of severity was categorized as follows: extreme, great, moderate, and little (on 4 to 1 point scale).

Data Analysis Approach:

The collected data were analyzed through the following statistical techniques and indices:

1. Frequency Index: A formula is used to rank causes of delay based on frequency of occurrence as identified by the participants.
2. Frequency Index = $(\sum (a n) \div N) * (100 \div 4)$
Where a is the constant expressing weighting given to each response (ranges from 1 for rarely up to 4 for always), n is the frequency of the responses, and N is the total number of responses.
3. Severity Index: A formula is used to rank causes of delay based on severity of occurrence as identified by the participants.
4. Severity Index = $(\sum (a n) \div N) * (100 \div 4)$
Where a is the constant expressing weighting given to each response (ranges from 1 for little up to 4 for severe), n is the frequency of the responses, and N is the total number of responses.
5. Importance Index: The importance index of cause is calculated as a function of both frequency and severity indices, as follows:
6. Importance Index (I.I %) = $(\text{Frequency Index} \% * \text{Severity Index} \%) \div 100$

DISCUSSIONS AND RESULTS

This section discusses the results obtained in the previous section. First, we discuss the severest and most frequent causes of delay within each group. Second, we discuss the most frequent effects of delay

Causes related to owner

Causes related to contractor

Causes related to consultant

Causes related to services and utilities

Causes related to Government regulations

Causes related to external environment

Delay effects

Results indicated that the four most frequent effects of delay are:

- Cost overrun
- Time overrun
- Disruption of traffic movement
- Dispute

When the project is subjected to delay, it will exceed the specified period which means waste of time that may be used in other profit making projects. As well as that, delay causes cost overrun because time is money. The contractor will pay more for overhead, labours and machinery. On the other hand, owner's money will be tied up with this delayed project. Moreover, closing main roads for development and construction will disrupt traffic movement. Additionally, roads provide links that connect the road users to other areas that may include recreational and investment projects. So delay in road projects may lead to delay in these investment projects that depend on them.

CONCLUSION AND RECOMMENDATIONS

The first step in reducing the delays in highway construction project is to understand the root causes of the delay. The results provide a listing of root causes and issues that are directly responsible for most infrastructure construction project delays. Additionally, it is found that fundamental principles must be adopted before significant improvements can be made. The data were collected from the following respondents....

Landmark Corporation Pvt Ltd Mumbai, Construct Infotech Mumbai, Patils Constructions Sangli, P.S.C Infracon Pvt Ltd Dattawadi, M/S Anant Associates Pune, Fabstruc Signs Pvt Ltd Mumbai, Destech Pvt Ltd Mumbai, J Kumars Construction Pvt Ltd Mumbai Etc.

This work discussed the delay in road projects in Bahrain. It studied the frequency and severity of delay causes, as well as the frequency of delay effects. The research is a field survey through a questionnaire directed to contractors, consultants, and owner who is the Ministry of Works. It was concluded that there are many causes of delay related to contractors such as Ineffective construction method implementation, Shortage of materials.

Payment problems between contractor and his employees . The major causes related to the owner, i.e. MOW, are Interference by the owner during execution operation, Delay in decision making by the owner, Delay in progress payments by owner. The main problems related to consultants are due to lack of experience. Delay causes related to services and utilities are the most critical factors as indicated by the high values of their severity means. Moreover, cost and time overruns and disruption of traffic movement were the most frequent effects of delay.

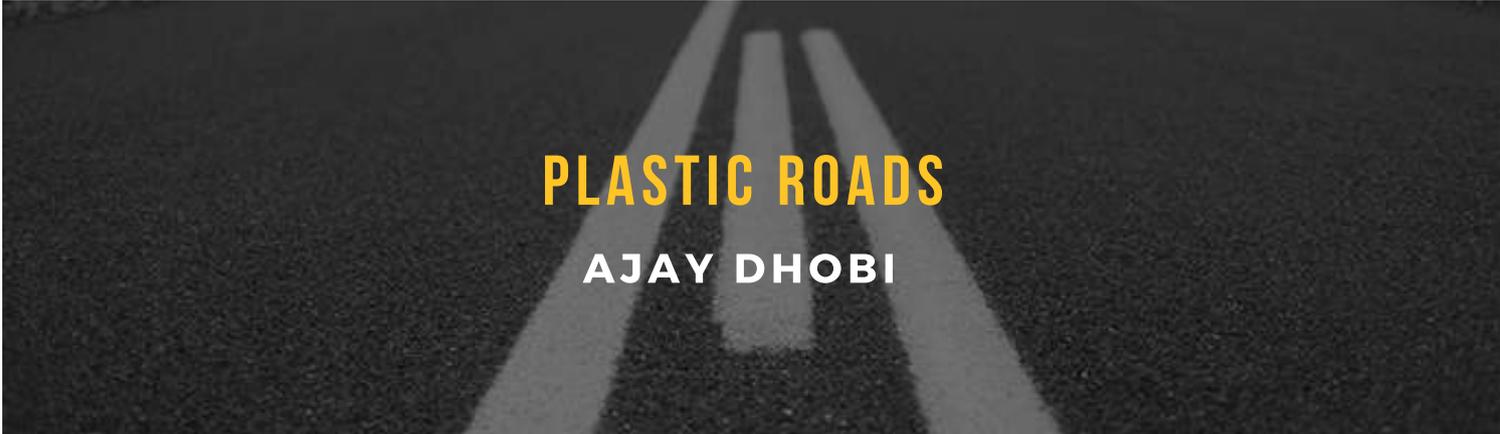
Recommendations for future studies

It is recommended to further this research by investigating actual delay case studies in India. Furthermore the associated cost of delay in highway projects should be studied and analysed.



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STUDENT'S CONTRIBUTION



PLASTIC ROADS

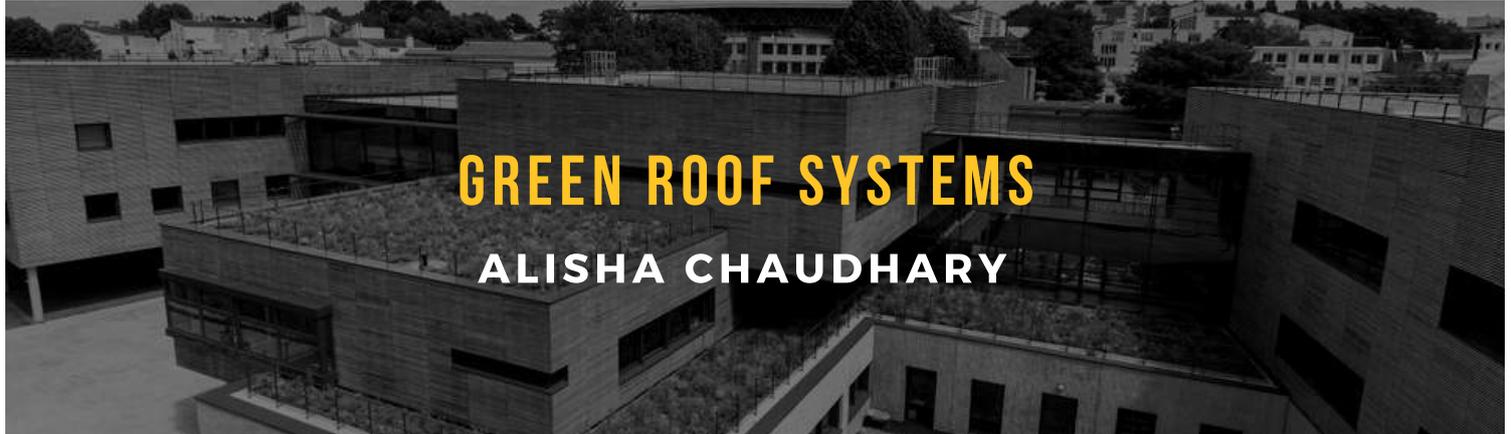
AJAY DHOBI

The world's production industries have generated tremendous amounts of economic growth since the 1800s, but the industrialization of cities has also led to significant challenges such as overcrowding and extreme pollution. Because urban environments are often home to many industrial facilities, people come to the city seeking employment, but large metropolitan hubs are running out of space to house their residents. With overcrowding, resource demands are increased, and as cities grow, urban environments may face more pressure in their attempts to provide large urban populations with sustainable supportive infrastructures like food, water, and safe roads. Advanced civil engineers are needed now more than ever to provide solutions to these critical issues; below are several developing innovations currently being used around the world to improve socio-environmental sustainability. As a response to massive local waste and plastic pollution within their country, India's government began experimenting with plastic roads during the early 2000s, with waste plastic being used as a construction material. An early report by India's Central Pollution Control Board discovered that even after four years of use, Jambulingam Street in Chennai—one of the first plastic roads—had not sustained much damage. The board cited that no potholes, rutting, raveling, or edge flaws were discovered during the evaluation. This level of performance attracted the interests of local governments, who were looking to rid the Tamil Nadu region's urban environments of the discarded shopping bags, foam packaging, and other unrecyclable plastic products that litter the streets. As of

2015, any Indian city with a population of at least 500,000 is required to construct their roads using waste plastic as a core material, in efforts to promote greater pollution control and environmental sustainability for Indian communities.

Although the concept of using waste plastic in roads is still in its early stages, with very few plastic roads currently existing in the Western world, civil engineering researchers in countries like the United Kingdom and the United States are working to design new technologies to support the safe implementation of waste plastic in road construction. One such development involves converting waste plastics into small balls that, when combined with asphalt or other common road components, create a strong, permeable surface that features hollow spaces that allow stormwater to seep through the road and more effectively recharge groundwater.

Transitioning to the use of plastic roads will lead to more manageable plastic waste and potentially, safer roads, but there are still some concerns regarding hazards that accompany plastic roads as they age. As these roads gradually deteriorate due to heat and light, they may dissolve into micro-plastics that give off harmful pollutants, affecting the functionality and biodiversity of soil and water resources. Creative civil engineers play a significant role in ensuring that the science behind using waste plastic for roads is accurate, and that future iterations of this concept are carried out with consideration for environmental health and safety.



GREEN ROOF SYSTEMS

ALISHA CHAUDHARY

The Environmental Protection Agency defines a green roof as a “vegetative layer grown on a rooftop.” Today, green roof systems have become popular all over the world, not only for their beauty, but also for the benefits they provide toward environmental sustainability. Germany is currently leading the world in green roof technologies, and they have implemented green roofing systems on approximately 10% of German homes since the technology emerged in the early 1970s. Civil engineers are responsible for ensuring that the green roof’s supportive infrastructure—for instance, a comprehensive watering system—is engineered to consistently deliver an appropriate amount of resources, and the roof itself must be designed to effectively provide working improvements to environmental sustainability.

However, civil engineers still face some obstacles when planning the installation and maintenance of green roof systems, like high costs and harsh climates, but innovations in modern engineering techniques for green roofing systems have allowed the industry to consistently offer the following environmental benefits to urban communities:

Enhanced Urban Biodiversity: Green roofs accommodate new flora, which may act as new habitats for different species of plants and animals.

Cooling of Buildings: The vegetation on the roof acts as thermal insulation, storing excess heat and decreasing peak temperatures within the

building. This means less energy must be consumed to heat the building, resulting in decreased energy costs and lower pollutant emissions.

Reduced Runoff Quantity: On average, green roofs retain 40-60% of total rainfall. Storing this rainwater as it falls has been shown to result in runoff reduction of 34% between September and February, and 67% between March and August. By reducing runoff, civil engineers that design green roof systems can limit strain on sewage systems and mitigate the costs of roof damage.

Pollution Control: Green roofs are composed of plants that absorb nitrogen, lead, zinc, and airborne pollutants like carbon dioxide. This absorption also reduces the negative effects of acid rain by raising the pH values of acid rainwater before it becomes runoff water.



Wall structure plays important roles in supporting the superstructure. In wall structure cement and bricks is an important material. However, cement and bricks manufacturing process will contribute to a high emission of carbon dioxide (CO₂) which may lead to global warming and due to environmental concerns of the cement industry there is need to develop alternatives materials such as fly ash, GGBS. Therefore, objective of this paper is to find an alternative solution to reduce this environmental problem.

The alternative way that can solve the problem is by replacing the use of bricks in building construction by plastic bottles filled with sand and instead of cement the fly ash based geopolymer cement is used. Plastic bottle bricks are very cheaper in cost therefore the dream of shelter of the poor people can be fulfilled by using these bricks.

INDUSTRIAL WASTES

Now-a-days disposal of different wastes produced from different Industries is a great problem. These materials pose environmental pollution in the nearby locality because many of them are non-biodegradable. In recent years, applications of industrial wastes have been considered in road construction with great interest in many industrialised and developing countries. The use of these materials in road making is based on technical, economic, and ecological criteria. The lack of traditional road materials and the protection of the

environment make it imperative to investigate the possible use of these materials carefully. India has a large network of industries located in different parts of the country and many more are planned for the near future. Several million metric tons industrial wastes are produced in these establishments.

Industrial wastes such as fly-ash, blast furnace slag and red mud are three major industrial wastes in India. Presently over 100 million tonnes of fly-ash, 12 million tonnes of blast furnace slag and nearly 4 million tonnes of red mud are generated. It is estimated that production of these waste will double in foreseeable future due to rapid expansion coal based power generation, and increase in the production of iron and steel and aluminium through primary processing.

PLASTIC WASTES

Plastic is one of the most disposable materials in the modern world. plastic bottles are increasingly becoming a menace to the environment due to the chemicals used in the manufacture, improper use and disposal. waste plastic bottles are used for filling up landfills which polluted to soil, choking water bodies and causing serious environmental consequences. on the other hand, world human population continually increase so needed more houses and land for construction. now a day, it is difficult to make own house for poor people of the world by using costly construction material.

STUDENT'S CONTRIBUTION

Conclusion:

- 1) Red mud and fly ash based geopolymer can act as a green alternative to cement.
- 2) The production of versatile, cost-effective geopolymer cements that can be mixed and hardened essentially like Portland cement would represent a “game changing” advancement, revolutionizing the construction of transportation infrastructure.
- 3) Much less energy consumption.
- 4) Almost no CO2 emissions.
- 5) Raw material low in a price and can be easily obtained.
- 6) Strength can be attained in a short time.
- 7) The compressive strength of geopolymer cement is 1.5 times more than that of ordinary Portland cement.
- 8) Greenhouse gas reduction potential as much as 90% when compared With OPC.
- 9) These bricks are very cheaper in cost therefore the dream of shelter of the poor people can be fulfilled by using these bricks.
- 10) These bricks provide good insulation as well as are bullet proof hence can be used in areas which are prone to attacks.
- 11) Overall eco brick is a cost efficient and resource efficient building material which can be used in order to deal with the various environmental problems as well for the reduction in the cost of construction.





Affordable housing and overcrowding in cities are putting pressure on urban populations to make changes. To combat these issues, civil engineers are designing floating homes—practical living spaces that sit upon the water. The homes are designed to resist floods by floating on top of water using a foundation of concrete and Styrofoam, which makes them virtually unsinkable. This approach means that homes can be built in spaces that were previously off-limits, like rivers, lakes and other bodies of water. Civil engineers predict that modern floating home technology will lower the costs of flood damage in urban cities, while also providing compact inner-city populations with more diverse housing options.

The concept of floating buildings is not new, as they can be found all over the world, especially in traditional Asian villages. Although with modern civil engineering knowledge, these structures—and the infrastructure needed to make them sustainable—are gradually becoming more reliable and easier to maintain. However, introducing this concept in urban environments with large populations will prove to be somewhat tricky, as structures being built within or on above-ground water sources could impact environments negatively by disturbing the natural state of the land beneath bodies of water (e.g. lake bottoms or the ocean floor). The effect of humans on the environment should not be underestimated either, so civil engineers will need to remain focused on creating systems that inhibit floating houses and their residents from disrupting local water ecosystems, while improving the viability of this technology for use in low-income areas.



COBIAX TECHNOLOGY

AVANISH RAI

General

Cobiax slab is a simple and brilliant technology investigated due to the need for a lighter and environmentally sustainable slabs. It will help to overcome many problems such as high cost buildings, the vibrations problems in solid slabs that happened for simple reason like human footfall, and other related problems. The technology based on creating hollows in the slab by using a spherical void formers.

The slab is very important structure member in building and slab is one of the largest member consuming concrete. When the load acting on the slab is large or clear span between columns is more, the slab thickness is on increasing. It leads to consume more material such as concrete and steel, due to that self-weight of slab is increase. To avoid these disadvantages varies. A voided flat plate slab system is known as one of the effective slab system, which can reduce self-weight of slab. A Cobiax slab has hollow void former made from recycled plastic placed within slab to reduce self-weight of slab. The Cobiax slab and solid slab are consider with interior span ranging from 6m × 6m to 18m × 18m having thickness from 280mm to 600mm having spherical balls into the slabs from 180mm to 450mm. Self-weight reductions, stiffness reduction factor and solid area for punching shear is derived for different cases of voided flat plate slab. Stiffness modification factor and weight reduction the second moment of inertia is a key variable when performing structural analysis of slab. The

untracked moment of inertia is dependent on the thickness and width of the flat plate slab and the contribution made by steel can be ignored since steel is not taking part prior to cracking in addition, the values in cobia technology.

The objective of project result is optimization of concrete and up to 35% reduction in the slab self-weight while still providing a high equivalent stiffness. This will enhance the bearing behavior on the whole structural elements by forming spherical or flattened rotational symmetrical shape inside the slab. Cobiax deck enables the construction of light weight, biaxial floor slabs with column grids ranging from 6m up to 18m without beams.

It doesn't only contribute to the building structurally but also has a great effect on the environment as we are reducing the amount of concrete used and replacing it with recycled products. Various attempts have been made in the past to reduce the weight of concrete slabs, without reducing the flexural strength of the slab. Reducing the own weight in this way would reduce deflections and make larger span lengths achievable. The economy of such a product will depend on the cost of the material that replaces the concrete with itself and air. Not all the internal concrete can be replaced though, since aggregate interlock of the concrete is important for shear resistance, concrete in the top region of the slab is necessary to form the compression block for flexural resistance, and concrete in the tension

STUDENT'S CONTRIBUTION

zone of the slab needs to bond with reinforcement to make the reinforcement effective for flexural resistance. Also, the top and bottom faces of the slab need to be connected to work as a unit and to insure the transfer of stresses.

The cobia method is the same as the concrete method but the only difference is that the dead load decreases due to the Cobiax balls (made from recycled polyethylene and it fills by air) by this method, the thickness of the slabs will be minimized significantly (in most cases). The structures usually have slim slabs and wide spans. In the same way, by reducing cost and materials, engineers can reach their goals much easier compared to the previous methods. The amount of footprint (carbon dioxide emission) is going to drop which means that this method is eco-friendlier than the other methods as well. The Length of the spans could reach up to 20m and the soffit is flat which can make a huge range of choices by pipes.

History

Cobiax is a voided slab systems, the concept of cobiax slab is based on non-working concrete or unnecessary dead load with voids. Voided slab systems are not new, the invention of void formers was in 1914. Cobiax company started its work in 1997 in Switzerland and then spread their project and companies to various countries and the Middle East in Dubai as regional office, then through a local business partner to Palestine. Cobiax void formers system differs from other systems in the geometry of the voided formers. It has a spherical shape so, there will be no stress concentration on edges, and also cobiax is more environmentally friend.

Stephenson shows some of advantages of Cobiax slabs and published a paper in London concrete association about the construction of a library leading to the pattern of semi-precast Cobiax slabs. He says (the construction time for the decks was reduced by 40%, dead load was reduced by 35% and carbon dioxide emissions were also cut by 1/3). According to Wolski et al. (2006)" It was found that Cobiax slabs show relatively lower natural frequencies relative to the other types" that's means Cobiax slabs better and more safe in seismic action. And

according to (Marais (2009))" It was elaborated that shear strength of a two way hollow core slab is significantly smaller than a solid slab, while the bending capacity is gained by and large as the same as a solid one" and this is considered as a weak point against Cobiax.

Engineering aspects of cobiax.

In general, in order to design and construct a building they should take care of several features. These include the load bearing; the amount of deformation that may occur in the span or the pillars (columns); the floors being acoustic and the design should reach the reasonable resistance to the fire. The cobiax method which is one of the newest and the ecological ways of construction, it has become popular in the recent years. In concrete slab, the density of the concrete is high and it is weak in tension. To overcome this issue, engineers add steel bars inside the concrete. In the majority of cases, there is one matrix of steel bars which is usually placed in the lower half of the slabs, in order to take tension strength. This acts on the concrete slabs. This combination makes the structure heavy at the same time, making the structure expensive. The concept of the cobiax method is to remove as much non-working dead load as possible by integrating the voids inside the slabs. This fact leads the considerable reduction in weight of the structure. On the other hand, the reinforcement required to support the loads on the structure is reduced. These aspects lead the final cost of the project to become more financial and the material usage gradually comes down. In addition, time consumption is cut significantly.

Cobiax Technology Work

The proposed designs will follow the same concept which Cobiax method used. It means that, the amount of concrete and the weight of slabs will be reduced by using balls. In other words, the aim of the proposed design is to maximize the dead load reduction. However, the difference is that the shape of the balls will be changed to oval shape. The sizes of the balls depend on each situation (loads) and the thickness of the slabs. The formwork which keeps the ball in its place. the oval balls and the bars inside the concrete. The oval shape

increases the capability of the design of the ball, which means that the length and height of the balls can be variable and customizable. The advantage of this design is that the number of balls will decrease because they are tandem and also the length of them is more than cobiax method. By the following reasons the number of balls and time consumption to produce is reducing. Another disparity is that the difference between the depth of the slabs and the height of the voids are in a range of 10 to 15 cm which means 100-150 mm concrete should be laid on top.

The cobiax flat slab has the same mechanical load bearing behavior as a solid flat plate slab. Cobiax void former modules consist of fixed reinforcement steel elements with integrated void formers made from one hundred percent recycled plastic material which is Polyethylene or Polypropylene. The Cobiax cage modules are positioned between the bottom and top reinforcement layers in the slab's cross section where they also serve as supporting cages. Product Range multiple void sizes can be provided for a wide range of slab thicknesses depending on span requirements and load applied. Depending of the slab thickness the Cobiax cage modules are available in two types Slim-Line and Eco line. Slab thickness from 20 to 45 cm with one layer. The slabs up to 70 cm with two layers Eco-Line Cobiax floor system consists of hollow plastic spheres cage into the concrete to create a grid of void formers inside the slab. The result is a flat slab soffit with the benefits of using flat slab formwork. With the reduction in concrete self-weight, large spans can be achieved without the use of prestressed cables, providing the imposed loads are low.

The high-density Polyethylene or Polypropylene spheres are fixed into 6mm diameter steel reinforcement cages. The rows of cages are placed adjacent to each other to form a grid of evenly spaced void formers. The cages with spheres are light-weight, allowing for quick placement and rapid construction.

Conclusion:

Engineers are looking to reduce the weight of the structure (mainly in slabs). The fact brings about many advantages such as a decrease in the project's time consumption, material usage, pollution and total cost.

The concrete frame is more common in these days because of the cost and easy access to this material. The cobiax method is the newest method which changed the construction industry. By using ball inside the concrete slab the weight of the slab will be minimize up to 35%. The following reduction brings many advantages such the distance of columns increase and there are no beams required.

The proposed design has the same idea and concept of cobiax. There are a few differences in the proposed design. The shape of the balls is oval (3D-Ellipse). By changing the shape of it can bring many advantages. The main difference is by reducing the number of balls, the more reduction in weight of slab occurs.

Another advantage of the design is instead of increasing the amount of reinforcement which makes the structure heavy. It is possible to reduce the reinforcement and make the basement more stable.

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